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The Comparative Winter Hardiness of Oat Varieties

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INTRODUCTION

Winter-killing is the major limiting factor in fall-sown oat production in the United States. Low temperature is the principal cause of winter-killing, although heaving, smothering, high winds, and unfavorable soil-moisture conditions may be contributing factors.

Reliable information as to the relative winter hardiness of different varieties seeded in the fall has been limited. The uniform winter-hardiness nurseries, begun in 1926 by the United States Department of Agriculture in cooperation with the State agricultural experiment stations, have in recent years supplied this need to a considerable degree, and it seems desirable to make this information more generally available. This circular reports the results for the 10-year period from 1927 to 1936.

MATERIAL AND METHODS

The data presented herein summarize experiments conducted in cooperation with State agricultural experiment stations for 1 to 10 years at 32 stations. The data cover a total of 179 station years. All important varieties believed to have possibilities for fall seeding have been grown, and promising new varieties have been included in these experiments as rapidly as they have become available. The location of the uniform nurseries, the cooperating agency, the cooperator, the number of years grown at each station, and the elevation and soil type for each station are presented in table 1. The location of each cooperating station is shown in figure 1.

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[1] The writer is indebted to S. C. Salmon and J. H. Martin, of the Division of Cereal Crops and Diseases, for valuable assistance and criticism in the preparation of this manuscript; to T. R. Stanton, of the Division of Cereal Crops and Diseases, for assistance in selecting and classifying the oat varieties and strains for testing; and to each of the numerous cooperators listed in table 1, who supplied data on the hardiness nurseries grown on their respective stations.

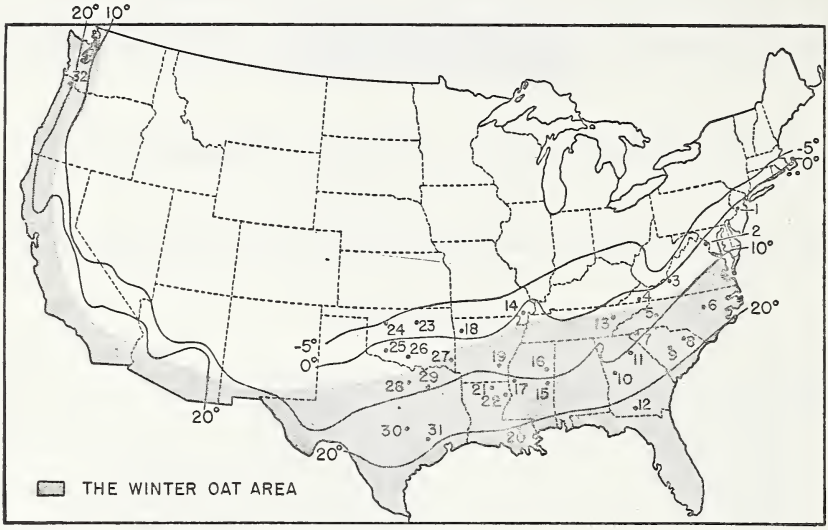

FIGURE 1.—Principal winter-oat area (shaded section) and location of stations cooperating in the winter-hardiness experiments. Figures refer to stations listed in table 1. (Outlines of temperature zones adapted from the Atlas of American Agriculture.)

TABLE 1.—*Location, altitude, and soil type of stations at which winter-hardiness nurseries were grown, and duration of tests and cooperator*

Location	Station	Number on map[1]	Altitude	Soil type	Cooperators[2]	Years grown
North Atlantic:			*Feet*			*Number*
New Jersey	New Brunswick	1	110	Silt loam	H. B. Sprague	4
North Central:						
Missouri	Sikeston	14	[3]325	do	B. M. King, Carl O. Luper.	1
South Atlantic:						
Virginia	Arlington	2	55	do	J. W. Taylor, R. E. Wester, Frank Stevenson.	9
	Blacksburg	3	2,100	do	M. S. Kipps, T. K. Wolfe, P. T. Gish.	9
	Glade Spring	4	2,100	do	R. W. Perkins	3
North Carolina	Statesville	5	950	Sandy loam	G. K. Middleton, J. W. Hendricks, P. H. Kime.	4
	Raleigh	6	376	do.[4]	G. M. Garren	3
South Carolina	Clemson	7	850	do	H. P. Cooper, T. S. Buie, B. E. G. Prichard, R. W. Wallace, R. W. Hamilton.	10
	Hartsville	8	227	do	Geo. J. Wilds	8
	Columbia	9	351	Sand	R. B. Carr	2

[1] See fig. 1.

[2] Persons transmitting data to U. S. Department of Agriculture. Cooperator in 1936 is listed first—the others follow.

[3] Approximation.

[4] Several soil types present.

TABLE 1.—*Location, altitude, and soil type of stations at which winter-hardiness nurseries were grown, and duration of tests and cooperator*—Continued

Location	Station	Number on map	Altitude	Soil type	Cooperators	Years grown
South Atlantic—Con.			*Feet*			*Number*
Georgia	Experiment	10	946	Clay loam	R. P. Bledsoe	10
	Athens	11	694	do	R. R. Childs	7
	Tifton	12	370	Sandy loam	H. S. Garrison	5
South Central:						
Tennessee	Knoxville	13	977	Silt loam	N. I. Hancock, H. P. Ogden.	7
Mississippi	State College	15	424	Houston clay.[4]	Fred O'Kelly, A. D. Suttle.	9
	West Point	16	237	do	T. F. Akers	6
	Stoneville	17	127	Silt loam	H. A. York. R. B. Carr.	7
Arkansas	Fayetteville	18	1,451	do	C K. McClelland	10
	Stuttgart	19	228	do	C. Roy Adair	6
Louisiana	Baton Rouge	20	60	do	John P. Gray	5
	Calhoun	21	180	Sandy loam	John P. Gray, Sidney Stewart.	5
	St. Joseph	22	78	Clay loam	John P. Gray, C. B. Haddon.	1
Oklahoma	Stillwater	23	880	Silt loam	C. B. Cross	5
	Woodward	24	2,002	Sandy loam	Edmund Stephens, J. B. Sieglinger.	5
	Heavener	27	500	do	C. B. Cross, H. F. Cobb.	2
	Lawton	25	1,111	Clay loam	W. M. Osborn	1
	Lone Grove	26	872	Sandy loam	C. B. Cross, G. W. Statton.	2
Texas	Denton	28	621	Clay loam	I. M. Atkins, P. B. Dunkle.	9
	Greenville	29	550	Houston clay.	H. C. McNamara, R. E. Wester.	8
	Temple	30	687	do	Henry Dunlavy	6
	College Station	31	308	Sandy loam	P. C. Mangelsdorf, G. T. McNess.	9
Western:						
Oregon	Astoria	32	70		Roderick Sprague	1
Total						179

In the experiments, 100 kernels of each variety were planted about 2 inches apart in rows usually 18 feet in length. With but few exceptions, all the seeds used were grown on the Arlington Experimental Farm near Arlington, Va.

The survival percentages were computed from counts of the seedlings in the fall after all plants had emerged and again in the spring after danger of killing freezes had passed.

The thin planting in these experiments gave less protection to the seedlings and probably resulted in heavier killing than if a larger quantity of seed had been sown in drills, as in the usual nursery yield tests. The latter method more nearly approaches practical field conditions but would tend to obscure differences in hardiness under mild conditions. The results obtained are in accord with those of several observations of relative hardiness of oat varieties grown in field-plot tests and are believed to be reliable within narrow limits.

EXPERIMENTAL RESULTS

At many stations in certain years, all varieties were killed completely or nearly so, and in others none was injured or the injury was so slight that no information as to relative winter hardiness was obtained.

The percentages of survival for each station for each year in which differential injury was recorded are presented in tables 2 to 11, inclusive. A summary is given in table 12. Of the 179 station-years represented by these experiments, differential injury was recorded in 138.

SURVIVAL IN 1927

Sixteen varieties were grown in the uniform winter-hardiness nurseries at seven stations in 1926–27. All varieties survived 100 percent at Clemson, S. C., and at State College, Miss. Survival data for the remaining five stations are given in table 2. Severe killing occurred at Arlington and considerable killing at Blacksburg, Va., and Fayetteville, Ark. Survival was relatively high at Athens and Experiment, Ga. The average survival for all stations ranged from 46.7 percent for the Red Rustproof strain, Ferguson No. 71, to 63.3 percent each for Dwarf Culberson, a strain of *Avena sativa*, and Appler, one of the Red Rustproof strains, a difference of 16.6 percent.

TABLE 2.—*Survival of varieties of winter oats in 1927* [1]

Species, group, and variety or selection	C. I. No.	Survival at—					Average
		Arlington, Va.	Blacksburg, Va.	Athens, Ga.	Experiment, Ga.	Fayetteville, Ark.	
Avena sativa							
Bicknell:		*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Bicknell	3218	14.8	61.6	96.6	85.1	44.8	60.6
Black Winter:							
Tech	947	15.3	29.5	97.8	82.6	42.4	53.5
Culberson:							
Culberson	273	5.4	60.6	97.8	80.6	48.4	58.6
Dwarf Culberson	748	22.9	78.5	97.8	83.9	33.3	63.3
Hairy Culberson	2505	18.6	32.6	89.9	87.6	84.3	62.6
Winter Turf:							
Winter Turf	3295	25.3	46.3	98.9	87.1	33.3	58.2
Do	3296	14.1	45.7	95.5	80.6	44.1	56.0
Lee:							
Custis	2041	11.0	54.7	94.3	81.4	39.5	56.2
Lee	2042	8.4	69.4	96.2	69.1	13.6	51.3
Avena byzantina							
Fulghum:							
Fulghum	708	8.2	51.3	97.5	96.4	13.3	53.3
Fulghum (winter type)	2499	11.9	61.5	100.0	94.0	37.3	60.9
Red Rustproof:							
Texas Red	775	3.5	51.1	97.7	96.6	3.4	50.5
Ferguson No. 71	844	0	57.7	87.1	85.4	3.4	46.7
Appler	1815	10.1	54.1	100.0	94.3	58.0	63.3
Texas No. 1118	1450	8.4	52.5	94.5	86.7	41.0	56.6
Miscellaneous strains:							
Culred	3217	18.5	33.0	91.8	75.0	37.5	51.2

[1] Data from Clemson, S. C., and State College, Miss., where all varieties survived 100 percent, are omitted.

SURVIVAL IN 1928

Twenty varieties and strains were grown in 1927–28. Two stations in Texas were added—College Station and Denton. The resulting data are presented in table 3. At all stations, Fulghum (C. I. 708) [2] was unintentionally omitted and a more hardy strain grown instead.

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[2] "C. I." refers to accession number of the Division of Cereal Crops and Diseases.

TABLE 3.—*Survival of varieties of winter oats in 1928* [1]

Species, group, and variety or selection	C. I. No.	Survival at—						Average
		Arlington, Va.	Blacksburg, Va.	Clemson, S. C.	Experiment, Ga.	State College, Miss.	College Station, Tex.	
Avena sativa								
Bicknell:		*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Bicknell	3218	94. 8	12. 3	100. 0	49. 5	4. 8	44. 1	50. 9
Black Winter:								
Tech	947	81. 6	25. 3	100. 0	12. 9	0	25. 0	40. 8
Culberson:								
Culberson	273	84. 9	11. 2	60. 0	30. 7	14. 9	20. 0	37. 0
Dwarf Culberson	748	81. 3	45. 8	85. 0	22. 5	2. 2	30. 1	44. 5
Hairy Culberson	2505	90. 6	51. 2	95. 0	33. 8	45. 8	48. 8	60. 9
Winter Turf:								
Winter Turf	3295	43. 8	31. 5	10. 0	17. 6	0	6. 9	18. 3
Do	3296	36. 4	2. 1	80. 0	19. 0	0	4. 6	23. 7
Lee:								
Custis	2041	70. 5	22. 4	80. 0	48. 8	0	9. 5	38. 5
Lee	2042	46. 3	6. 7	70. 0	27. 4	0	4. 2	25. 8
Avena byzantina								
Fulghum:								
Fulghum selection [2]	------	86. 0	22. 1	100. 0	33. 3	9. 6	18. 1	44. 9
Fulghum (winter type)	2498	74. 4	37. 8	80. 0	7. 3	0	1. 2	33. 5
Do	2499	68. 4	35. 3	30. 0	20. 2	0	11. 9	27. 6
Do	2500	79. 3	41. 4	10. 0	17. 0	1. 1	8. 4	26. 2
Red Rustproof:								
Texas Red	775	16. 3	14. 6	0	3. 5	0	3. 5	6. 3
Ferguson No. 71	844	34. 7	20. 9	5. 0	3. 8	0	3. 7	11. 4
Ferguson No. 922	2150	3. 5	24. 1	5. 0	2. 4	0	4. 2	6. 5
Hastings Hundred Bushel	2462	6. 5	41. 7	5. 0	0	0	9. 8	10. 5
Appler	1815	86. 6	18. 1	85. 0	33. 3	7. 4	30. 7	43. 5
Nortex	2382	54. 6	54. 9	0	2. 2	0	11. 5	20. 5
Miscellaneous strains:								
Culred	3217	61. 5	8. 9	60. 0	21. 4	0	6. 0	26. 3

[1] Data from Athens, Ga., Fayetteville, Ark., and Denton, Tex., where all varieties were killed 100 percent, are omitted.

[2] Through an error, Fulghum (C. I. 708) was not sown, a much more hardy strain of Fulghum being substituted for it.

All varieties winter-killed completely at Athens, Ga., Fayetteville, Ark., and Denton, Tex.; hence no data were obtained from these stations. Differential killing was recorded at six stations. Wide variation in the survival of different varieties was observed, especially at Arlington, Va., Clemson, S. C., and State College, Miss., and severe killing was observed in all varieties at Blacksburg, Va., Experiment, Ga., and College Station, Tex. The highest average percentage of survival for all stations where differential killing was recorded was 60.9 percent for Hairy Culberson, and the lowest 6.3 and 6.5 percent for Texas Red and Ferguson No. 922, respectively, both strains of Red Rustproof. Dwarf Culberson, which equaled the best in 1926–27, survived only 44.5 percent. This was the first season in which there was an indication of superior hardiness of Hairy Culberson.

SURVIVAL IN 1929

The winter-hardiness nurseries were sown on 12 experiment stations in the fall of 1928, 3 more than in the fall of 1927. Raleigh, N. C., Hartsville, S. C., and Greenville, Tex., were included for the first time. A total of 24 varieties and strains were grown. Those included for the first time were Norton (C. I. 2501), Coker selection 7a–20–5–3 (C. I. 2504), Texas selection 1118–69 (C. I. 2503), and Arkansas selection 160 (C. I. 2502). Fulghum (C. I. 708) replaced Fulghum selection. The winter of 1928–29 was comparatively favorable for fall-sown oats, the survival for all varieties was unusually high, and the differences were less than usual. Plants at Arlington, Va., were destroyed in the fall by plant aphids, no report was received for the Blacksburg (Va.) nursery, and there was no killing at Hartsville, S. C. Differential killing was recorded at 9 stations. The data are recorded in table 4. Very little killing occurred at State College, Miss., and at College Station and Greenville, Tex. As an average for the 9 stations, Bicknell survived the best and Norton the least. The range from the most to the least hardy was only 11.6 percent, however, and it appears doubtful whether much significance should be attached to the small differences generally observed.

TABLE 4.—*Survival of varieties of winter oats in 1929*[1]

Species, group, and variety or selection	C. I. No.	Survival at—									Average
		Raleigh, N. C.	Clemson, S. C.	Athens, Ga.	Experiment, Ga.	State College, Miss.	Fayetteville, Ark.	College Station, Tex.	Denton, Tex.	Greenville, Tex.	
Avena sativa		*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Bicknell:											
Bicknell	3218	93.5	80.0	100.0	72.2	98.9	89.5	98.9	77.3	93.9	89.4
Black Winter:											
Tech	947	62.1	81.0	75.9	55.3	98.8	91.0	87.4	83.1	94.7	81.0
Culberson:											
Culberson	273	76.3	77.0	83.0	77.4	97.8	86.4	100.0	87.5	94.7	86.7
Dwarf Culberson	748	72.4	80.0	88.9	89.7	100.0	66.1	100.0	91.6	94.9	87.1
Arkansas selection 160	2502	71.0	75.0	82.3	72.1	98.9	90.5	91.8	53.4	93.9	81.0
Hairy Culberson	2505	69.8	79.0	85.4	68.7	100.0	84.0	100.0	93.9	96.9	86.4
Winter Turf:											
Winter Turf	3295	67.1	84.0	83.7	86.5	100.0	82.5	100.0	72.9	88.7	85.0
Do	3296	68.2	87.0	83.0	85.4	98.9	62.5	100.0	96.9	90.9	85.9
Lee:											
Custis	2041	65.9	85.0	91.7	74.1	100.0	74.6	100.0	67.0	88.3	83.0
Lee	2042	73.3	77.0	81.0	78.1	100.0	82.7	100.0	77.7	96.8	85.2
Avena byzantina											
Fulghum:											
Fulghum	708	60.0	85.0	89.0	68.3	100.0	86.4	100.0	54.4	90.9	81.6
Fulghum (winter type)	2498	58.3	84.0	81.5	72.8	100.0	89.4	92.2	92.4	96.9	85.3
Do	2499	73.9	83.0	83.7	74.1	98.9	77.6	100.0	96.8	95.9	87.1
Do	2500	75.0	87.0	91.6	74.7	98.9	89.8	100.0	89.2	96.9	89.2
Red Rustproof:											
Texas Red	775	60.6	76.0	81.6	79.3	100.0	76.7	100.0	82.5	93.9	83.4
Ferguson No. 71	844	51.1	80.0	83.5	71.6	100.0	85.0	96.7	75.8	94.7	82.0
Ferguson No. 922	2150	75.3	78.0	94.1	86.4	98.6	89.4	100.0	25.3	92.3	82.2
Hastings Hundred Bushel	2462	75.0	80.0	97.4	77.0	100.0	95.7	100.0	82.0	95.9	89.2
Appler	1815	77.8	80.0	83.3	70.5	98.9	88.3	96.8	95.8	96.8	87.6
Nortex	2382	65.8	(2)	82.4	67.5	98.9	94.3	97.6	47.7	95.6	[3] 81.2
Texas selection 1118–69	2503	80.0	76.0	83.1	71.3	98.9	88.4	100.0	91.8	95.7	87.2
Miscellaneous strains:											
Culred	3217	58.1	75.0	85.1	68.2	100.0	77.5	97.8	73.8	95.7	81.2
Norton	2501	69.8	73.0	84.5	66.3	100.0	71.3	92.6	50.5	91.8	77.8
Coker selection 7a–20–5–3	2504	72.6	79.0	78.0	65.9	98.9	79.4	94.2	91.7	96.8	84.1

[1] Data from Hartsville, S. C., where all varieties survived 100 percent, are omitted. All varieties at Arlington, Va., were destroyed by aphids. No report received from Blacksburg, Va.

[2] Did not germinate at Clemson, S. C.

[3] Average of 8 stations only.

SURVIVAL IN 1930

Percentage survival for the winter-hardiness nurseries at which differential killing was recorded in 1929–30 are presented in table 5. They were grown for the first time at Knoxville, Tenn., Stoneville, Miss., and Temple, Tex. No data were obtained at State College, Miss., because of weather conditions unfavorable for germination. All varieties were winter-killed at Blacksburg, Va., Raleigh, N. C., Stoneville, Miss., and Denton, Tex., and no data are presented for these stations. Differential killing, such as to secure indications of relative hardiness, was thus recorded at only nine stations. Most varieties were completely, or almost completely, killed at Knoxville, Tenn., Fayetteville, Ark., Greenville, Temple, and College Station, Tex. A few strains were completely winter-killed at Arlington, Va., and Athens and Experiment, Ga.

TABLE 5.—*Survival of varieties of winter oats in 1930* [1]

Species, group, and variety or selection	C. I. No.	Survival at—										Average
		Arlington, Va.	Knoxville, Tenn.	Hartsville, S. C.	Clemson, S. C.	Athens, Ga.	Experiment, Ga.	Fayetteville, Ark.	Greenville, Tex.	Temple, Tex.	College Station, Tex.	
Avena sativa		*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Bicknell:												
Bicknell	3218	68.1	1.1	94.9	84.9	28.8	34.4	1.1	0	5	0	31.8
Black Winter:												
Tech	947	74.6	3.1	96.9	77.2	17.4	29.4	16.7	0	2	0	31.7
Culberson:												
Culberson	273	69.6	4.3	93.6	80.0	28.4	49.5	9.8	0	5	0	34.0
Dwarf Culberson	748	81.5	0	92.3	81.5	13.2	25.0	2.4	0	6	0	30.2
Arkansas selection 160	2502	43.2	5.7	94.6	58.9	31.5	31.9	1.2	0	0	0	26.7
Hairy Culberson	2505	74.5	0	94.8	92.1	32.8	62.5	5.4	1	2	0	36.5
Winter Turf:												
Winter Turf	3295	27.5	0	99.0	58.9	5.4	15.4	0	0	0	0	20.6
Do	3296	30.3	0	92.9	57.1	16.5	19.0	4.1	0	1	0	22.1
Spören Gray Winter	2506	72.9	0	94.7	66.0	15.3	23.9	7.1	0	0	0	28.0
Lee:												
Custis	2041	68.2	0	90.5	72.1	3.6	0	0	0	1	0	23.5
Lee	2042	69.7	0	83.0	79.3	3.3	8.5	0	0	1	0	24.5
Avena byzantina												
Fulghum:												
Fulghum	708	22.6	0	100.0	53.7	1.3	0	0	0	0	1.3	17.9
Fulghum (winter type)	2498	23.2	0	94.7	83.0	25.9	43.8	1.1	0	0	0	27.2
Do	2499	0	4.4	94.8	81.3	44.6	46.5	7.0	0	3	1.7	28.3
Do	2500	0	0	98.9	62.6	29.1	20.3	13.3	0	2	0	22.6
Do	3232	50.7	0	98.9	60.9	14.3	27.7	0	0	0	5.8	25.8
Red Rustproof:												
Texas Red	775	60.5	0	93.7	46.3	5.9	1.6	0	0	0	0	20.8
Ferguson No. 71	844	7.3	3.3	99.0	53.9	21.1	23.0	0	0	1	0	20.9
Ferguson No. 922	2150	83.3	0	94.5	59.0	0	3.1	0	0	3	0	24.3
Hastings Hundred Bushel	2462	62.7	0	100.0	47.1	0	0	0	0	3	0	21.3
Appler	1815	66.7	1.1	97.4	67.8	0	2.2	2.2	0	1	0	23.8
Nortex	2382	67.2	0	92.9	67.5	1.2	0	0	0	3	0	23.2
Texas 1118-69	2503	9.4	0	93.3	36.5	0	0	0	0	3	0	14.2
Miscellaneous strains:												
Culred	3217	55.1	5.4	95.8	46.1	12.2	26.7	1.2	0	2	0	24.5
Coker 7a-20-5-3	2504	34.4	0	94.5	79.1	27.4	27.5	0	0	2	0	26.5

[1] Data from Blacksburg, Va., Raleigh, N. C., Stoneville, Miss., and Denton, Tex., where all varieties were killed 100 percent, are omitted.

Twenty-five varieties and strains were grown. Those included for the first time were Spören Gray Winter (C. I. 2506), a strain imported from Germany, very similar to Winter Turf, and a winter type selection from Fulghum (C. I. 2500). The highest average percentage of survival for those stations at which differential killing occurred was 36.5 for Hairy Culberson (C. I. 2505), and the lowest, 14.2 percent, for Texas selection No. 1118–69.

Survival in 1931

The winter-hardiness nurseries were grown at 17 experiment stations in 1930–31 and reports were received from 16 of them. West Point, Miss., and Stuttgart, Ark., were included for the first time. Twenty-four strains were grown, these being the same as for 1929–30 except for the omission of Coker selection (C. I. 2504). The winter of 1930–31 was exceptionally mild, and little evidence of winter injury was observed at any of the stations with the exception of Knoxville, Tenn., Clemson, S. C., Athens, Ga., and West Point, Miss. Complete survival was reported for Raleigh, N. C., Hartsville, S. C., Stoneville, Miss., and Denton and Greenville, Tex. At Arlington, Va., no seedlings emerged in the fall, owing to drought, and therefore no data were obtained. As 90 percent or more of almost all strains survived, even on those stations where some killing occurred, there were no outstanding differences in survival. Data for the 10 stations at which differential winter-killing was recorded are given in table 6.

Table 6.—*Survival of varieties of winter oats in 1931* [1]

Species, group, and variety or selection	C. I. No.	Survival at—										Average
		Knoxville, Tenn.	Clemson, S. C.	Athens, Ga.	Experiment, Ga.	State College, Miss.	West Point, Miss.	Fayetteville, Ark.	Stuttgart, Ark.	Temple, Tex.	College Station, Tex.	
Avena sativa		*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Bicknell:												
Bicknell	3218	76.5	70.1	94.6	96.7	95.3	80.0	85.4	95.9	91.6	98.7	88.5
Black Winter:												
Tech	947	81.0	74.7	81.8	93.4	98.9	90.2	81.2	92.9	93.3	93.4	88.1
Culberson:												
Culberson	273	69.2	65.2	91.5	97.8	97.6	85.2	84.6	95.8	95.5	98.3	88.1
Dwarf Culberson	748	81.1	70.7	97.8	95.6	100.0	92.9	86.8	94.9	98.9	97.6	91.6
Arkansas selection 160	2502	93.2	70.7	94.4	96.6	100.0	100.0	93.6	88.0	90.0	97.8	92.4
Hairy Culberson	2505	79.5	80.8	85.3	97.8	98.8	87.3	87.2	96.0	96.8	90.5	90.0
Winter Turf:												
Winter Turf	3295	91.7	72.2	94.4	95.6	91.2	100.0	91.8	94.9	92.6	95.8	92.0
Do	3296	90.5	74.5	95.9	98.9	94.4	96.9	81.1	94.0	93.8	96.3	91.6
Spören Gray Winter	2506	------	56.7	80.9	96.6	100.0	98.3	92.9	83.3	97.4	94.8	[2] 89.0
Lee:												
Custis	2041	88.0	67.6	95.5	98.9	96.7	78.8	84.7	100.0	98.9	98.9	90.8
Lee	2042	93.3	72.1	96.8	97.8	97.6	80.4	88.4	93.8	90.8	87.4	89.8
Avena byzantina												
Fulghum:												
Fulghum	708	87.9	83.3	88.3	100.0	95.7	45.7	87.4	97.9	98.9	95.8	88.1
Fulghum (winter type)	2498	91.5	73.6	98.9	94.6	100.0	95.8	82.8	99.0	97.8	96.5	93.1
Do	2499	94.1	69.7	90.2	93.2	97.6	90.2	94.6	96.0	100.0	90.9	91.7
Do	2500	84.4	75.5	92.0	96.9	100.0	94.9	92.9	96.0	93.3	100.0	92.6
Do	3232	------	55.9	81.3	98.8	100.0	96.0	100.0	93.8	100.0	96.4	[2] 91.4
Red Rustproof:												
Texas Red	775	74.4	69.8	95.8	96.8	95.7	92.1	92.6	95.0	98.9	95.5	90.7
Ferguson No. 71	844	85.7	73.6	90.4	97.8	98.9	77.4	98.9	95.3	95.5	97.1	91.1
Ferguson No. 922	2150	84.3	62.5	69.0	94.9	100.0	80.0	100.0	92.5	96.7	95.0	87.5
Hastings Hundred Bushel	2462	82.3	75.8	92.5	100.0	95.1	85.0	98.8	97.7	95.5	95.9	91.9
Appler	1815	95.7	86.7	94.9	99.0	96.9	71.9	89.4	98.0	95.6	94.2	92.2
Nortex	2382	84.3	68.4	93.5	98.9	100.0	84.5	87.5	97.9	97.8	94.0	90.7
Texas 1118-69	2503	89.9	53.2	93.5	100.0	97.3	78.0	96.6	96.8	94.6	96.0	89.6
Miscellaneous strains:												
Culred	3217	89.0	68.6	71.9	93.1	98.6	76.8	77.5	85.9	91.0	97.3	85.0

[1] Data from Raleigh, N. C., Hartsville, S. C., Stoneville, Miss., Denton and Greenville, Tex., where all varieties survived 100 percent, are omitted.

[2] Average for 9 stations only.

SURVIVAL IN 1932

Winter-hardiness nurseries were sown at 23 experiment stations in the fall of 1931. Those on which they were grown for the first time are Columbia, S. C., Tifton, Ga., Baton Rouge, Calhoun, and St. Joseph, La., and Stillwater and Woodward, Okla. Raleigh, N. C., was omitted. Only one new strain, Coker selection Big Boy (C. I. 2910), was included. The winter of 1931–32 was comparatively mild, and no killing was reported at Hartsville, S. C., or at College Station, Denton, and Greenville, Tex. Data for the remaining stations are presented in table 7. Survival was relatively high at all stations, those at which marked differential killing was recorded being State College, Miss., Fayetteville, Ark., Knoxville, Tenn., and Stillwater, Okla., only. The highest average survival for 19 stations was 91.3 percent for Lee (C. I. 2042) and the lowest 75.9 percent from Fulghum (C. I. 708). Dwarf Culberson and Culberson, which were among the hardiest in former years, survived 84.6 and 90.3 percent, respectively.

TABLE 7.—*Survival of varieties of winter oats in 1932* [1]

Species, group, and variety or selection	C. I. No.	Survival at—																			Average
		Arlington, Va.	Blacksburg, Va.	Knoxville, Tenn.	Clemson, S. C.	Columbia, S. C.	Athens, Ga.	Experiment, Ga.	Tifton, Ga.	State College, Miss.	Stoneville, Miss.	West Point, Miss.	Fayetteville, Ark.	Stuttgart, Ark.	Baton Rouge, La.	Calhoun, La.	St. Joseph, La.	Temple, Tex.	Stillwater, Okla.	Woodward, Okla.	
Avena sativa																					
Bicknell:		*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Bicknell	3218	96.7	87.5	40.3	98.5	98.9	83.3	97.7	84.8	66.2	90.7	82.2	54.9	98.9	89.1	100.0	98.7	100.0	89.3	100.0	87.2
Black Winter:																					
Tech	947	96.5	61.3	44.4	82.3	95.7	75.4	97.4	80.0	82.1	98.2	89.7	36.9	98.0	86.7	88.5	96.1	100.0	44.9	100.0	81.8
Culberson:																					
Culberson	273	97.6	95.8	79.2	95.5	96.8	83.3	98.9	87.0	75.3	94.9	93.8	51.1	100.0	87.7	94.1	98.9	100.0	85.2	100.0	90.3
Dwarf Culberson	748	95.5	89.3	58.8	92.2	100.0	86.6	94.7	72.7	81.3	100.0	97.5	42.9	90.9	67.2	80.0	93.6	98.6	68.7	97.0	84.6
Arkansas selection 160	2502	77.0	92.4	39.5	91.7	95.7	88.7	98.8	82.9	65.8	96.3	93.2	50.0	93.3	82.1	92.3	97.2	100.0	74.1	100.0	84.8
Hairy Culberson	2505	94.7	94.9	71.4	98.6	100.0	78.7	100.0	78.8	77.0	98.4	100.0	48.8	94.8	76.4	75.9	93.2	96.7	87.4	100.0	87.7
Winter Turf:																					
Winter Turf	3295	100.0	86.4	78.1	93.2	100.0	92.2	97.9	84.3	81.5	98.3	100.0	46.1	94.9	94.8	93.1	100.0	97.6	55.0	97.1	89.0
Do	3296	100.0	90.9	88.3	94.2	100.0	80.5	97.9	84.1	81.0	96.5	100.0	48.8	96.8	96.3	100.0	95.4	100.0	57.8	100.0	89.9
Spören Gray Winter	2506	97.7	82.4	84.3	86.0	96.7	93.2	92.8	89.0	66.3	92.0	86.2	47.0	90.1	93.3	84.4	100.0	98.7	65.2	98.8	86.5
Lee:																					
Custis	2041	87.2	92.7	76.7	98.8	98.0	86.1	100.0	93.8	69.4	100.0	97.5	48.8	100.0	83.3	81.1	97.6	98.8	37.4	97.0	86.5
Lee	2042	96.5	97.2	90.1	95.5	97.8	85.7	98.9	100.0	80.7	98.3	100.0	56.6	100.0	88.6	90.0	98.7	97.8	61.4	100.0	91.3
Avena byzantina																					
Fulghum:																					
Fulghum	708	95.4	97.0	36.8	87.5	99.0	76.1	97.6	89.6	45.1	92.3	100.0	8.1	93.8	18.6	100.0	98.8	97.6	7.9	100.0	75.9
Fulghum (winter type)	2498	86.6	95.9	74.3	93.5	100.0	86.6	100.0	91.5	79.1	94.6	100.0	76.4	100.0	83.6	84.0	98.8	97.7	57.3	100.0	89.5
Do	2499	93.0	97.2	81.9	97.6	89.3	90.0	97.5	97.6	78.2	100.0	96.6	85.7	96.8	80.6	95.5	92.0	98.8	57.3	100.0	90.8
Do	3232	89.7	93.4	83.1	88.0	100.0	86.7	98.9	88.1	80.7	92.7	96.9	71.7	94.5	73.2	75.0	92.7	98.8	56.7	100.0	87.4
Red Rustproof:																					
Texas Red	775	97.9	84.7	97.5	98.9	99.0	91.9	97.7	92.5	70.9	100.0	100.0	21.3	96.9	79.7	100.0	100.0	98.8	14.3	95.7	86.2
Ferguson No. 71	844	96.4	92.8	89.6	94.6	98.9	91.4	100.0	90.9	68.8	96.4	92.0	43.5	92.8	75.8	85.0	100.0	98.7	68.4	98.4	88.1
Ferguson No. 922	2150	91.3	93.2	91.0	92.0	97.9	93.0	100.0	88.6	61.3	98.1	100.0	47.3	92.5	72.9	78.6	98.9	97.8	13.6	100.0	84.6
Hastings Hundred Bushel	2462	88.9	91.1	94.0	85.7	97.8	90.9	98.8	94.3	80.7	96.3	95.1	48.8	95.7	67.6	86.7	100.0	100.0	36.4	92.2	86.4
Appler	1815	91.5	92.1	89.7	82.1	98.9	90.4	100.0	97.6	60.0	94.6	94.4	44.3	92.0	84.9	91.7	100.0	97.8	12.4	92.1	84.6
Nortex	2382	88.3	97.5	95.8	93.9	97.9	90.9	98.9	96.3	79.6	98.3	93.3	51.4	92.7	80.5	88.9	96.4	100.0	44.3	90.7	88.2

Miscellaneous strains:																					
Culred	3217	80.2	93.5	54.1	95.0	100.0	83.3	96.9	94.1	79.8	98.2	95.7	57.6	100.0	90.2	87.8	100.0	100.0	61.0	100.0	87.8
Burt Georgia 25-3	2684	86.7	91.7	19.7	89.7	100.0	82.6	93.5	88.7	81.5	96.6	96.2	56.0	91.9	91.2	96.9	90.8	100.0	88.3	100.0	86.4
Norton strain 3	2909	87.0	96.5	65.0	94.1	100.0	92.0	100.0	74.7	72.2	86.5	85.0	65.7	89.5	34.3	85.7	97.7	100.0	38.3	100.0	82.3
Coker selection Big Boy	2910	89.0	95.8	35.3	92.2	100.0	93.6	100.0	89.2	76.3	98.3	100.0	51.7	92.7	40.6	80.0	100.0	100.0	65.9	98.6	84.2

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[1] Data from Hartsville, S. C., College Station, Denton, and Greenville, Tex., where all varieties survived 100 percent, are omitted.

Survival in 1933

Pertinent data from 20 winter-hardiness nurseries in which differential killing occurred in 1932-33 are presented in table 8. Stations at which the nurseries were grown for the first time are New Brunswick, N. J., and Statesville, N. C. Unfavorable weather and soil conditions prevented the seeding of the nurseries at St. Joseph, La., and Temple, Tex. All varieties survived 100 percent at Hartsville, S. C., and killing was complete at Denton and Greenville, Tex., and at Lone Grove and Woodward, Okla. Data from these stations are omitted.

TABLE 8.—*Survival of varieties of winter oats in 1933* [1]

Species, group, and variety or selection	C. I. No.	Survival at—																				Average
		Arlington, Va.	Blacksburg, Va.[2]	Knoxville, Tenn.	New Brunswick, N.J.	Statesville, N. C.	Clemson, S. C.	Columbia, S. C.	Athens, Ga.	Experiment, Ga.	Tifton, Ga.	State College, Miss.	Stoneville, Miss.	West Point, Miss.	Fayetteville, Ark.	Stuttgart, Ark.	Baton Rouge, La.	Calhoun, La.	College Station, Tex.	Heavener, Okla.	Stillwater, Okla.	
Avena sativa																						
Bicknell:		*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Bicknell	3218	92.8	50.6	84.0	81.5	100.0	76.9	100.0	95.7	97.7	100.0	97.1	96.6	43.1	53.5	60.4	97.9	88.5	100.0	81.3	0	79.9
Black Winter:																						
Tech	947	100.0	31.8	92.0	87.7	93.2	92.6	90.8	94.5	96.7	98.9	64.5	92.5	45.8	10.0	68.8	93.4	70.7	100.0	81.2	1.4	75.3
Culberson:																						
Culberson	273	95.2	46.6	90.0	97.2	100.0	84.0	98.9	92.6	96.6	90.9	89.8	89.1	71.4	90.0	81.0	98.6	88.5	100.0	96.2	0	84.8
Hairy Culberson	2505	91.3	32.4	93.0	100.0	100.0	81.8	100.0	91.0	100.0	89.7	100.0	98.2	61.4	37.0	78.7	89.1	100.0	92.7	91.0	1.3	81.4
Winter Turf:																						
Winter Turf	3295	96.6	61.1	89.0	88.9	100.0	87.0	97.9	96.1	97.8	93.5	82.9	89.3	41.9	14.9	62.9	96.6	76.7	90.7	92.0	0	77.8
Do	3296	95.1	36.9	90.0	97.3	100.0	90.5	95.7	97.8	98.9	90.6	67.6	92.2	40.0	5.6	80.0	100.0	76.1	88.7	94.1	0	76.9
Spören Gray Winter	2506	94.7	32.8	92.0	87.5	98.8	88.2	100.0	93.0	97.8	100.0	77.6	87.5	21.1	59.6	69.0	96.8	78.2	100.0	100.0	2.6	78.9
Lee:																						
Custis	2041	96.7	23.2	91.0	77.2	100.0	90.0	94.6	95.7	96.8	90.5	77.6	95.9	69.2	16.5	50.0	95.2	68.5	96.7	96.8	1.3	76.2
Lee	2042	100.0	14.8	90.0	98.2	100.0	92.1	100.0	94.4	96.8	91.8	60.5	92.0	35.0	5.4	78.9	96.4	63.5	100.0	80.7	2.5	74.7
Avena byzantina																						
Fulghum:																						
Fulghum	708	92.2	(3)	60.0	60.0	96.1	86.7	100.0	86.5	89.9	91.4	19.7	90.7	13.6	4.1	46.7	95.6	72.1	26.3	74.7	0	[4] 63.5
Fulghum (winter type)	2498	92.2	21.8	65.0	97.3	98.8	88.2	100.0	87.6	97.8	90.9	57.9	85.2	38.3	32.4	76.6	91.7	78.0	87.1	95.3	0	74.1
Do	2499	89.5	38.2	90.0	78.7	96.4	82.6	95.6	92.2	100.0	92.8	72.5	88.5	52.8	18.3	68.7	93.3	72.9	100.0	75.8	0	74.9
Do	3232	90.7	15.8	88.0	84.8	96.6	92.3	96.8	90.4	100.0	95.0	59.8	84.9	30.0	1.8	71.6	98.1	78.6	97.6	96.3	0	73.5

[1] Data from Hartsville, S. C., where all varieties survived 100 percent, and from Denton and Greenville, Tex., and Lone Grove and Woodward, Okla., where all varieties were killed 100 percent, are omitted from this table.

[2] Average of 2 spring readings.

[3] Not planted.

[4] Average for 19 stations only.

TABLE 8.—*Survival of varieties of winter oats in 1933*—Continued

Species, group, and variety or selection	C. I. No.	Survival at—																				Average
		Arlington, Va.	Blacksburg, Va.[2]	Knoxville, Tenn.	New Brunswick, N.J.	Statesville, N. C.	Clemson, S. C.	Columbia, S. C.	Athens, Ga.	Experiment, Ga.	Tifton, Ga.	State College, Miss.	Stoneville, Miss.	West Point, Miss.	Fayetteville, Ark.	Stuttgart, Ark.	Baton Rouge, La.	Calhoun, La.	College Station, Tex.	Heavener, Okla.	Stillwater, Okla.	
Avena byzantina—Continued																						
Red Rustproof:		*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Ferguson No. 71	844	92.6	58.1	85.0	57.7	98.8	92.0	100.0	94.4	95.7	94.1	56.9	90.2	36.4	5.0	78.3	95.5	83.3	84.8	50.0	0	72.4
Ferguson No. 922	2150	98.8	31.1	92.0	66.1	97.7	77.8	97.9	86.3	99.0	96.7	5.3	78.2	42.6	4.4	84.4	97.1	100.0	64.4	75.3	0	69.8
Hastings Hundred Bushel	2462	96.6	50.7	80.0	47.3	97.6	81.8	97.0	98.9	98.9	94.3	4.8	68.5	34.5	.6	76.2	97.5	75.9	42.7	70.8	0	65.7
Appler	1815	92.6	58.2	83.0	57.9	97.7	93.1	100.0	91.2	94.8	97.7	42.9	79.6	43.6	3.4	79.6	96.1	57.8	47.6	42.9	0	68.0
Nortex	2382	96.7	33.3	75.0	34.9	98.8	83.3	95.6	92.7	99.0	96.5	10.1	85.7	52.2	0	64.2	98.6	87.8	38.5	78.7	0	66.1
Miscellaneous strains:																						
Culred	3217	91.3	23.1	91.0	74.5	98.8	92.9	100.0	87.1	100.0	95.2	61.9	86.2	29.6	46.7	66.7	94.4	62.2	92.9	83.5	0	73.9
Burt Georgia 25-3	2684	92.3	0	90.0	52.9	95.9	91.3	97.9	89.0	98.9	85.7	50.0	89.1	34.3	13.9	57.8	97.6	73.5	100.0	90.9	0	70.1
Norton strain 3	2909	93.9	8.7	90.0	43.6	97.8	93.9	95.4	93.3	95.8	81.2	65.1	88.9	13.1	2.3	52.2	89.6	89.2	100.0	55.2	0	67.5
Coker selection Big Boy	2910	93.1	9.3	84.0	65.4	94.9	87.5	97.1	95.3	94.7	88.5	32.9	89.3	45.0	33.1	64.2	89.3	61.8	82.9	72.7	0	69.1
Victoria	2401	68.8	(3)	0	0	43.7	93.1	89.4	75.3	7.7	83.3	0	0	1.9	0	9.6	92.9	6.5	0	0	0	[4] 30.1
Bond	2733	85.2	(3)	5.0	0	63.7	82.4	98.9	90.7	87.5	94.4	0	62.9	3.4	.6	9.1	100.0	27.6	0	15.9	0	[4] 43.5
Alber	2766	48.7	(3)	5.0	0	48.8	89.5	96.7	87.9	91.4	100.0	72.5	61.9	1.7	3.7	1.2	98.6	74.5	11.1	19.4	0	[4] 48.0

[2] Average of 2 spring readings.
[3] Not planted.
[4] Average for 19 stations only.

A total of 25 varieties and strains was grown. Those included for the first time were Victoria (C. I. 2401), Bond (C. I. 2733), and Alber (C. I. 2766), the first two of which are highly resistant to crown rust and of considerable interest from that viewpoint. Dwarf Culberson (C. I. 748), Arkansas selection No. 160 (C. I. 2502), and Texas Red (C. I. 775) were omitted. The highest average survival of any strain was 84.8 percent, recorded for Culberson (C. I. 273). Hairy Culberson ranked second and Bicknell third. The new varieties Victoria, Bond, and Alber survived only 30.1, 43.5, and 48.0 percent, respectively, as compared with 63.5 percent for Fulghum (C. I. 708), the least hardy variety grown for many years. It is evident that these varieties are distinctly lacking in winter hardiness.

SURVIVAL IN 1934

The winter-hardiness nurseries were grown at 21 stations in 1933–34. The following stations either did not sow nurseries or failed to report: Blacksburg, Va., Columbia, S. C., Athens, Ga., Lone Grove and Heavener, Okla., St. Joseph, La., and Temple, Tex. A nursery was sown for the first time at Glade Spring, Va. Twenty-six varieties and strains were grown, including all those grown the previous season and one additional variety, Coker selection 32–1 (C. I. 3026). All strains survived 100 percent at Stillwater, Okla., and Denton, Tex., and all were winter-killed at Glade Spring, Va., and Knoxville, Tenn. Most strains survived nearly 100 percent at Tifton, Ga., State College and Stoneville, Miss., Baton Rouge and Calhoun, La., and College Station and Greenville, Tex. Severe killing occurred at New Brunswick, N. J. Data are presented in table 9 for 17 stations at which differential killing occurred.

TABLE 9.—*Survival of varieties of winter oats in 1934* [1]

Species, group, and variety or selection	C. I. No.	Survival at—																	Average
		New Brunswick, N. J.	Arlington, Va.	Fayetteville, Ark.	Stuttgart, Ark.	Statesville, N. C.	Clemson, S. C.	Hartsville, S. C.	Experiment, Ga.	Tifton, Ga.	State College, Miss.	Stoneville, Miss.	West Point, Miss.	Baton Rouge, La.	Calhoun, La.	College Station, Tex.	Greenville, Tex.	Woodward, Okla.	
Avena sativa																			
Bicknell:		*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Bicknell	3218	11.5	74.7	90.9	88.0	72.2	92.6	94.7	73.0	100.0	100.0	98.5	80.3	88.0	78.2	99.0	92.1	100.0	84.3
Black Winter:																			
Tech	947	3.2	40.9	75.3	84.0	76.3	79.3	60.5	81.1	100.0	97.5	100.0	44.3	89.4	85.5	98.9	100.0	100.0	77.4
Culberson:																			
Culberson	273	8.7	66.8	79.1	94.5	80.0	88.9	95.7	77.5	98.8	97.5	100.0	81.3	73.0	86.1	96.8	91.3	98.4	83.2
Hairy Culberson	2505	4.0	72.8	100.0	86.3	64.2	72.6	95.0	75.3	96.9	97.5	100.0	81.5	85.0	90.9	94.4	80.3	100.0	82.2
Winter Turf:																			
Winter Turf	3295	4.0	41.5	79.1	80.2	58.6	92.6	41.9	86.2	100.0	97.7	100.0	44.2	91.0	87.2	100.0	87.8	93.1	75.6
Do	3296	0	61.1	87.2	81.5	59.0	70.4	53.3	96.7	96.9	97.6	100.0	58.6	95.5	94.7	95.8	73.8	100.0	77.8
Spören Gray Winter	2506	21.4	85.9	100.0	88.8	77.8	82.8	91.7	89.6	98.9	92.0	97.0	53.7	89.8	88.2	100.0	100.0	100.0	85.7
Lee:																			
Custis	2041	0	74.2	100.0	88.8	62.1	81.9	72.0	94.4	100.0	97.5	98.3	34.2	90.1	83.1	95.8	100.0	100.0	80.7
Lee	2042	4.4	84.8	97.6	88.2	62.2	79.1	53.3	93.2	98.8	98.7	100.0	46.6	96.2	91.7	98.9	84.4	97.6	80.9
Avena byzantina																			
Fulghum:																			
Fulghum	708	0	16.3	92.1	81.0	34.5	76.6	42.6	42.5	95.6	89.2	96.8	45.3	92.9	93.8	100.0	100.0	93.0	70.1
Fulghum (winter type)	2498	8.7	27.5	98.5	86.1	74.3	93.3	64.9	93.0	94.4	100.0	100.0	53.1	82.0	89.9	95.7	82.1	98.8	79.0
Do	2499	0	70.3	100.0	88.9	69.0	86.6	45.2	87.5	97.8	98.9	98.0	45.3	94.8	97.3	98.9	84.1	100.0	80.2
Do	3232	0	65.6	95.6	86.6	64.2	94.6	66.7	92.0	100 0	98.7	96.6	74.1	90.4	95.9	94.8	91.4	94.0	82.4
Red Rustproof:																			
Ferguson No. 71	844	4.0	79.3	91.1	90.1	59.0	83.3	51.0	86.7	98.8	100.0	97.0	36.9	83.8	100.0	95.7	89.6	98.8	79.1
Ferguson No. 922	2150	0	16.1	100.0	90.6	39.5	86.3	41.7	88.9	100.0	95.3	96.8	66.7	88.2	92.5	98.9	76.6	92.7	74.8
Hastings Hundred Bushel	2462	4.0	19.6	98.4	83.5	57.1	84.5	33.3	79.3	98.9	92.9	100.0	45.6	93.0	93.8	98.0	83.5	95.3	74.2
Appler	1815	0	67.1	95.1	72.7	41.2	90.9	82.8	86.4	98.8	100.0	100.0	65.5	95.2	91.8	96.8	75.3	93.8	79.6
Nortex	2382	0	25.6	100.0	86.6	46.1	84.0	35.1	77.8	97.4	96.4	98.4	67.9	95.2	91.8	100.0	78.2	94.2	75.0

Miscellaneous strains:																			
Culred	3217	14.3	71.7	100.0	87.6	78.2	80.9	47.1	84.1	98.8	96.4	100.0	61.0	91.1	88.9	100.0	87.7	90.7	81.1
Burt Georgia 25-3	2684	0	67.0	87.5	83.9	83.3	92.9	70.3	93.3	98.9	94.4	100.0	93.9	90.8	86.2	99.0	100.0	98.8	84.7
Norton strain 3	2909	5.0	21.3	75.0	88.2	73.2	88.5	47.6	87.6	96.4	93.8	100.0	73.2	81.1	87.4	98.9	100.0	88.2	76.8
Coker selection Big Boy	2910	4.3	8.2	91.9	96.1	62.2	85.6	36.4	74.4	97.7	95.8	100.0	73.0	92.9	86.8	96.8	100.0	83.7	75.6
Victoria	2401	0	1.1	0	21.7	0	27.1	0	11.3	96.0	0	12.5	3.8	88.1	92.6	100.0	96.4	0	32.4
Bond	2733	0	0	23.7	81.9	15.9	34.9	0	15.4	95.7	0	81.0	3.8	93.4	94.0	96.8	66.7	0	41.4
Alber	2766	0	1.1	64.5	84.4	2.6	34.8	0	25.6	100.0	92.9	88.5	7.7	92.7	100.0	100.0	93.2	85.5	57.3
Coker selection 32-1	3026	-------	37.4	-------	-------	90.0	85.2	63.8	85.3	100.0	96.5	96.9	75.0	77.8	86.4	94.6	100.0	-------	[2] 83.8

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[1] Data from Denton, Tex., and Stillwater, Okla., where all varieties survived 100 percent, and from Glade Spring, Va., and Knoxville, Tenn., where all varieties were killed 100 percent, are omitted from this table.

[2] Average for 13 stations only.

Wide variations in the survival percentages were recorded. For those stations where killing occurred, Spören Gray Winter ranked first, with a survival of 85.7 percent; Burt Georgia 25–3 (C. I. 2684) next, with 84.7 percent; and Bicknell third. Bond and Victoria gave the lowest survival percentages, 41.4 and 32.4 percent, respectively. The 2 years' tests with Bond and Victoria are believed to have shown clearly that these varieties are not winter hardy.

SURVIVAL IN 1935

Table 10 presents data from the 19 stations where differential killing was recorded in 1934–35. The nurseries were sown at 25 stations, Lawton, Okla., being included for the first time. The seed reached Blacksburg, Va., too late to be sown.

TABLE 10.—*Survival of varieties of winter oats in 1935* [1]

Species, group, and variety or selection	C. I. No.	Survival at—																			Average
		New Brunswick, N. J.	Arlington, Va.	Glade Spring, Va.	Knoxville, Tenn.	Fayetteville, Ark.	Stuttgart, Ark.	Statesville, N. C.	Clemson, S. C.	Hartsville, S. C.	Experiment, Ga.	Tifton, Ga.	State College, Miss.	Stoneville, Miss.	West Point, Miss.	Baton Rouge, La.	Calhoun, La.	College Station, Tex.	Greenville, Tex.	Stillwater, Okla.	
Avena sativa																					
Bicknell:		Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
Bicknell	3218	78.0	38.2	100.0	98.2	98.7	86.1	88.0	96.7	91.6	92.3	96.7	76.5	95.7	74.7	96.8	94.7	5.5	7.1	0	74.5
Black Winter:																					
Tech	947	49.0	22.1	94.2	92.1	82.1	81.5	85.9	89.9	78.4	90.1	95.7	55.6	100.0	64.4	91.1	93.9	31.3	8.9	0	68.7
Culberson:																					
Culberson	273	74.5	21.7	95.8	93.0	100.0	92.5	90.0	91.2	77.2	83.6	97.8	85.7	100.0	73.7	79.3	94.4	45.3	13.2	0	74.2
Hairy Culberson	2505	87.9	14.9	100.0	94.7	97.4	89.2	86.9	85.3	91.4	87.8	98.9	81.3	95.8	83.3	88.0	89.7	44.6	12.5	0	75.2
Winter Turf:																					
Winter Turf	3295	26.2	48.3	100.0	98.4	97.3	83.8	77.3	88.8	89.5	89.0	91.4	79.2	100.0	96.4	93.7	95.9	3.1	1.1	0	71.5
Do	3296	31.1	60.2	94.7	94.6	98.7	92.6	89.4	97.9	89.6	87.7	100.0	68.8	93.0	95.1	89.1	88.9	5.3	0	0	72.5
Spören Gray Winter	2506	58.3	75.9	81.3	90.3	97.4	84.2	92.9	94.4	95.7	91.0	97.8	100.0	95.8	79.0	95.6	95.3	0	4.3	0	75.2
Lee:																					
Custis	2041	31.7	41.3	97.0	94.3	92.6	73.8	97.5	97.6	87.6	80.8	100.0	73.7	100.0	89.1	95.4	91.3	5.8	3.2	0	71.2
Lee	2042	14.3	45.2	100.0	93.8	54.1	92.3	92.1	85.9	83.5	79.2	100.0	70.0	89.1	93.4	94.9	92.3	4.2	10.2	0	68.1
Avena byzantina																					
Fulghum:																					
Fulghum	708	2.5	46.8	100.0	96.4	22.0	78.1	90.6	72.5	58.2	86.5	96.5	90.0	84.1	95.7	96.4	88.3	0	1.3	1.1	63.5
Fulghum (winter type)	2498	22.9	35.5	94.0	93.1	89.6	80.0	93.7	89.2	82.3	83.3	100.0	78.9	97.5	74.4	88.7	94.4	1.3	5.7	0	68.7
Do	2499	47.8	37.9	90.4	94.6	94.3	89.2	93.9	88.9	78.7	80.3	100.0	76.5	93.0	87.3	95.8	92.8	5.4	1.1	0	70.9
Do	3232	34.0	38.8	96.6	96.4	86.5	79.4	96.2	83.1	93.7	84.4	100.0	92.9	95.2	96.5	92.9	96.3	1.4	0	0	71.8
Fulghum (winter type, Tennessee selection 090)	3175	65.9	41.0	98.3	95.2	100.0	87.5	------	90.6	90.9	84.0	100.0	85.7	95.6	98.8	96.1	98.5	63.6	10.2	0	[2] 77.9
Red Rustproof:																					
Ferguson No. 922	2150	17.4	15.7	100.0	93.0	59.7	87.3	95.5	95.3	65.1	74.0	95.1	68.4	97.5	98.8	89.4	88.5	3.0	3.3		65.6
Hastings Hundred Bushel	2462	21.6	37.3	100.0	91.2	40.5	87.3	95.8	91.1	47.1	80.0	96.6	54.5	86.4	93.5	95.6	87.7	0	4.4	0	63.7
Appler	1815	12.2	31.6	96.6	92.1	37.0	57.5	90.7	83.1	53.8	80.9	96.5	64.7	94.6	86.6	96.6	91.5	4.2	0	0	61.6
Nortex	2382	8.1	32.2	96.2	94.7	54.6	89.1	98.6	88.4	55.4	81.8	95.5	75.0	100.0	90.4	94.3	94.2	2.8	3.1	0	66.0

[1] Data from Temple and Denton, Tex., and Heavener, Lone Grove, Lawton, and Woodward, Okla., where all varieties were killed 100 percent, are omitted from this table.

[2] Average for fewer than 19 stations; hence not strictly comparable with other averages.

TABLE 10.—*Survival of varieties of winter oats in 1935*—Continued

Species, group, and variety or selection	C. I. No.	Survival at—																			Average
		New Brunswick, N. J.	Arlington, Va.	Glade Spring, Va.	Knoxville, Tenn.	Fayetteville, Ark.	Stuttgart, Ark.	Statesville, N. C.	Clemson, S. C.	Hartsville, S. C.	Experiment, Ga.	Tifton, Ga.	State College, Miss.	Stoneville, Miss.	West Point, Miss.	Baton Rouge, La.	Calhoun, La.	College Station, Tex.	Greenville, Tex.	Stillwater, Okla.	
Miscellaneous strains:		*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Culred	3217	17.3	36.7	96.6	93.2	97.3	75.4	94.8	89.1	92.1	84.5	100.0	100.0	88.6	95.2	93.8	93.8	32.0	0	0	72.7
Alber	2766	2.6	5.8	95.0	94.1	0	43.4	28.3	81.3	2.2	17.9	94.6	25.0	100.0	97.2	96.4	87.0	0	0	0	45.8
Coker selection 32-1	3026	32.4	30.5	100.0	88.6	87.7	93.1	95.0	91.8	100.0	92.9	100.0	83.3	97.0	90.5	90.1	92.6	8.1	6.9	0	72.7
Coker selection 33-50	3167	0	17.1	98.3	92.3	11.9	67.7	81.0	71.2	95.1	87.3	100.0	71.4	86.5	95.4	92.3	89.2	0	0	0	60.9
Coker selection 33-47	3176	2.6	23.5	83.6	77.3	78.6	79.7	86.8	78.7	79.3	82.7	97.4	69.2	94.3	94.3	93.9	100.0	0	0	2.7	64.5
Markton×Red Rustproof	3178	(3)	59.3	(3)	(3)	(3)	84.3	87.3	78.7	98.7	94.0	95.3	84.2	86.8	81.5	95.5	85.4	21.3	0	0	[2] 70.2
Do	3179	(3)	85.7	(3)	(3)	(3)	90.9	86.6	86.2	90.0	85.5	100.0	71.4	92.1	80.0	93.3	95.7	5.5	0	0	[2] 70.9

[2] Average for fewer than 19 stations; hence not strictly comparable with other averages.
[3] Not grown.

The nurseries included a total of 25 varieties and strains. Those grown in 1933–34 but omitted from the 1934–35 nurseries were Ferguson No. 71 (C. I. 844), Bond (C. I. 2733), Victoria (C. I. 2401), Norton strain 3 (C. I. 2909), Coker selection Big Boy (C. I. 2910), and Burt Georgia 25–3 (C. I. 2684). New strains included for the first time were Fulghum (winter type, Tenn. sel. 090, C. I. 3175), Coker selection 33–50 (C. I. 3167), Coker selection 33–47 (C. I. 3176), Markton × Red Rustproof (C. I. 3178), and Markton × Red Rustproof (C. I. 3179).

Winter-killing was more general than usual, and average survival was materially less than in other seasons. At Heavener, Lone Grove, Woodward, and Lawton, Okla., and Temple and Denton, Tex., all varieties and strains were killed 100 percent. At no station was 100-percent survival recorded for all varieties; however, very high survivals were recorded for nearly all at Glade Spring, Knoxville, Statesville, Clemson, Tifton, Stoneville, Baton Rouge, and Calhoun. Severe killing of all varieties occurred at Greenville and College Station, Tex., and Stillwater, Okla., and severe killing was recorded for many of them at New Brunswick, N. J., Arlington, Va., Fayetteville, Ark., and State College, Miss.

Based on results from the 19 stations where differential killing occurred, the highest survival, 77.9 percent, was recorded for Fulghum (winter type, Tenn. sel. 090, C. I. 3175). An average survival of 75.2 percent was recorded for Hairy Culberson (C. I. 2505) and for Spören Gray Winter (C. I. 2506). The lowest survival, 45.8 percent, was recorded for Alber (C. I. 2766).

SURVIVAL IN 1936

In 1935–36 one new station, Sikeston, in extreme southeast Missouri, was added to the uniform nurseries. No nurseries were sown at Heavener or Lone Grove, Okla., making a total of 26 for the season. No new varieties were included and none was dropped. All varieties were killed at Arlington, Va., and Woodward, Okla., and all survived at College Station, Tex. Table 11 presents data for the remaining 23 stations at which differential killing was recorded. Survival was nearly complete at Stuttgart, Ark., Clemson, S. C., and Tifton, Ga. At Baton Rouge and Calhoun, La., and Astoria, Oreg., some indications of reduction in stands were noted in a few varieties. Most of them survived almost fully. At New Brunswick, N. J., Blacksburg and Glade Spring, Va., Knoxville, Tenn., Experiment, Ga., Stillwater, Okla., and Sikeston, Mo., severe or complete killing occurred in many varieties.

The highest survival recorded was 62.7 percent for Tennessee selection 090 (C. I. No. 3175), a selection from Fulghum (winter type, C. I. 2499). This was followed by Fulghum (winter type, C. I. 2499), the parent variety, which survived 57.6 percent, Bicknell (C. I. 3218) with 57.4 percent, and Hairy Culberson (C. I. 2505) with 56.5 percent. The lowest survivals were recorded for Alber (C. I. 2766) with 30.8 percent. All other varieties survived from 40 to 60 percent except Coker selection 33–50, which survived 38.9 percent.

TABLE 11.—*Survival of varieties of winter oats in 1936* [1]

Species, group, and variety or selection	C. I. No.	Survival at—																						Average
		New Brunswick, N. J.	Blacksburg, Va.	Glade Spring, Va.	Knoxville, Tenn.	Fayetteville, Ark.	Stuttgart, Ark.	Statesville, N. C.	Clemson, S. C.	Hartsville, S. C.	Experiment, Ga.	Tifton, Ga.	State College, Miss.	Stoneville, Miss.	West Point, Miss.	Baton Rouge, La.	Calhoun, La.	Sikeston, Mo.	Temple, Tex.	Denton, Tex.	Greenville, Tex.	Stillwater, Okla.	Lawton, Okla.	Astoria, Oreg.	
Avena sativa																									
Bicknell:		*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Bicknell	3218	12.5	5.6	12.2	12.3	77.1	92.1	32.6	80.0	73.3	10.6	96.0	86.7	74.5	87.3	95.7	100.0	57.7	100.0	55.3	40.0	12.9	30.4	75.8	57.4
Black Winter:																									
Tech	947	16.0	6.1	41.7	8.6	68.8	97.6	19.1	84.6	63.8	7.4	93.7	85.5	74.1	98.7	94.4	92.9	38.9	69.7	15.6	27.6	4.3	20.0	83.7	52.7
Culberson:																									
Culberson	273	0	10.8	13.3	15.6	51.7	92.7	18.2	94.4	60.5	10.9	97.9	77.9	60.7	100.0	95.8	94.9	69.6	94.4	53.3	2.2	13.3	27.0	68.7	53.5
Hairy Culberson	2505	31.6	10.3	13.3	19.4	62.8	84.6	38.5	100.0	63.8	9.9	97.9	78.7	68.5	96.4	88.6	93.2	40.7	97.7	26.9	19.7	26.4	38.0	92.5	56.5
Winter Turf:																									
Winter Turf	3295	0	3.7	3.3	3.2	69.2	93.4	22.5	80.2	61.8	17.2	96.9	90.1	54.5	95.7	97.8	97.6	34.4	90.9	33.3	24.3	4.3	25.0	89.4	51.7
Do	3296	10.0	4.7	12.2	1.5	46.4	90.6	49.4	85.4	67.4	5.7	96.0	81.2	59.5	90.9	95.6	100.0	33.3	88.4	15.4	35.5	5.6	31.5	98.9	52.4
Spören Gray Winter	2506	4.5	4.3	5.6	9.1	84.6	89.5	41.3	91.8	46.1	15.0	95.7	86.7	62.3	100.0	91.4	93.4	50.0	95.6	29.6	27.6	5.8	41.3	88.2	54.8
Lee:																									
Custis	2041	4.3	3.2	9.6	5.7	43.2	87.0	65.2	85.3	61.4	12.8	94.6	89.2	65.5	67.5	95.5	93.3	25.9	91.2	5.9	34.6	6.7	27.1	100.0	51.1
Lee	2042	14.3	8.0	9.7	5.4	45.8	75.0	34.8	84.6	57.4	12.0	86.7	88.6	67.3	40.8	95.7	90.1	57.1	83.5	25.7	24.1	5.5	25.0	85.1	48.8
Avena byzantina																									
Fulghum:																									
Fulghum	708	5.0	33.0	25.3	0	43.1	94.2	21.3	93.2	68.5	16.8	88.5	82.8	69.6	9.1	96.8	100.0	21.7	67.0	51.9	15.1	1.1	7.1	97.9	48.2
Fulghum (winter type)	2498	5.9	16.5	19.6	2.9	43.3	93.6	38.2	77.9	84.8	5.2	93.8	95.0	82.0	83.8	97.9	92.9	58.1	86.5	34.4	22.4	8.1	20.4	90.6	54.5
Do	2499	0	18.9	7.8	12.5	79.2	93.1	42.5	89.4	86.0	7.4	98.9	83.7	81.0	2.7	98.9	98.0	54.9	99.0	77.1	47.8	23.8	26.4	94.9	57.6
Do	3232	4.8	40.2	25.8	1.4	77.6	91.3	20.7	81.2	74.0	3.3	92.6	84.0	69.6	20.3	96.8	96.8	32.8	85.7	36.0	19.7	9.3	25.0	97.8	51.6
Fulghum (winter type, Tennessee selection 090)	3175	12.5	29.4	11.5	15.8	80.3	100.0	17.3	91.3	80.0	12.0	100.0	80.6	84.1	70.1	95.5	91.8	62.1	100.0	81.8	59.5	27.3	40.8	97.9	62.7
Red Rustproof:																									
Ferguson No. 922	2150	0	6.0	7.1	0	50.0	90.0	14.8	88.6	25.3	5.6	90.7	68.7	39.4	38.5	95.2	92.6	16.4	95.2	9.5	17.7	0	13.6	98.9	41.9
Hastings Hundred Bushel	2462	0	10.0	10.6	0	45.9	98.8	35.2	85.1	32.9	8.7	100.0	74.1	41.0	32.4	97.8	100.0	11.5	94.4	16.7	30.8	1.3	11.8	82.3	44.4
Appler	1815	0	28.2	3.3	0	73.0	88.9	49.5	84.4	38.8	5.3	99.0	48.8	47.1	20.6	100.0	94.8	13.0	95.5	21.4	4.2	1.1	4.7	95.5	44.2
Nortex	2382	0	11.1	3.3	3.2	40.0	98.9	30.3	83.3	26.3	4.4	98.9	65.5	32.6	24.6	97.8	100.0	13.1	83.8	16.3	31.0	1.1	8.4	91.3	42.0

Miscellaneous strains:																									
Culred	3217	13.6	4.5	19.8	0	50.0	85.7	21.6	94.3	47.2	8.7	89.4	83.6	64.9	15.3	96.9	94.9	29.9	87.1	34.5	34.2	25.3	30.2	98.9	49.2
Alber	2766	0	0	15.4	0	19.7	91.5	0	61.1	6.4	0	96.8	62.5	48.0	3.7	91.1	90.0	3.1	63.0	4.8	2.9	0	3.4	43.9	30.8
Coker selection 32-1	3026	13.0	33.0	7.8	6.9	81.2	100.0	20.7	86.0	75.6	10.1	97.8	63.3	65.7	12.0	93.8	92.7	9.9	81.1	72.3	61.4	23.4	30.8	98.9	53.8
Coker selection 33-50	3167	0	9.5	12.6	0	21.3	96.2	1.4	89.0	23.8	1.1	90.0	62.5	41.7	0	91.6	90.3	0	74.4	21.6	1.8	1.2	68.2	96.3	38.9
Coker selection 33-47	3176	0	19.3	14.9	0	79.0	97.6	5.6	98.9	58.1	8.6	93.8	61.8	62.3	44.6	82.8	76.1	15.5	88.0	46.4	29.2	7.1	11.0	100.0	47.9
Markton × Red Rustproof	3178	4.3	49.5	15.1	9.1	69.2	97.9	11.1	96.3	67.4	18.8	92.4	80.0	62.5	2.6	92.5	95.9	7.0	77.5	32.5	22.4	6.7	31.9	100.0	49.7
Do	3179	0	26.7	4.9	11.1	56.8	96.5	23.2	99.0	68.5	9.5	92.9	73.3	47.8	2.5	94.8	94.9	10.0	63.6	32.3	17.4	4.6	7.9	100.0	45.1

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[1] Data from College Station, Tex., where all varieties survived 100 percent, and from Arlington, Va., and Woodward, Okla., where all varieties were killed 100 percent, are omitted from this table.

VARIETAL COMPARISONS

The relative survival for all varieties and for all nurseries in which differential killing occurred is summarized by years and variety in table 12. For convenience, data for 12 varieties that were grown in all tests are summarized by year and variety in table 13, and by variety and station in table 14. In tables 12 and 13 the weighted-average survival of each variety is expressed as a percentage of the two Winter Turf strains for the same years. This is included for convenience in comparing those varieties grown less than the full period. In considering varietal differences, a question of immediate concern is whether the relative survival of varieties is substantially the same for all stations and for all years. The data for Hairy Culberson, which gave the highest average survival, and for Fulghum (C. I. 708,) which has the lowest, are plotted for years (fig. 2) and for stations (fig. 3). Hairy Culberson survived better than Fulghum in every year, although the difference was greater in some years than in others. It is doubtful whether this latter, i. e., the apparent differential response to season, is greater than can reasonably be explained by random errors. On the other hand, the data suggest some differential response between

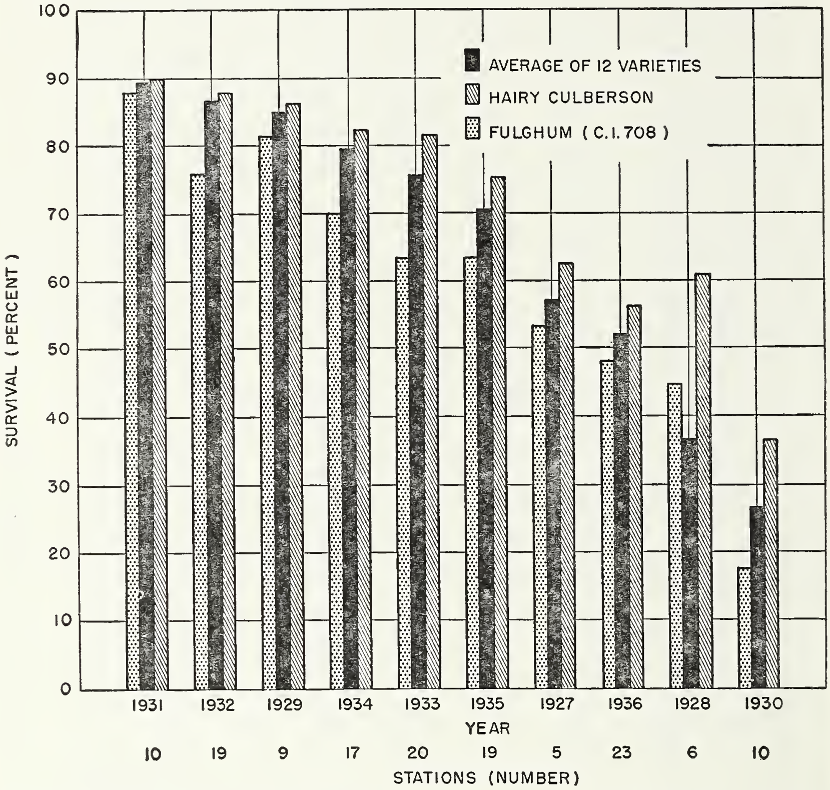

FIGURE 2.—Comparative survival of Hairy Culberson and Fulghum (C. I. 708).

stations. Thus, the generally more hardy Hairy Culberson had a slightly poorer survival than Fulghum (C. I. 708) at Blacksburg and Glade Spring, Va., Calhoun and St. Joseph, La., Athens, Ga., and Astoria, Oreg.

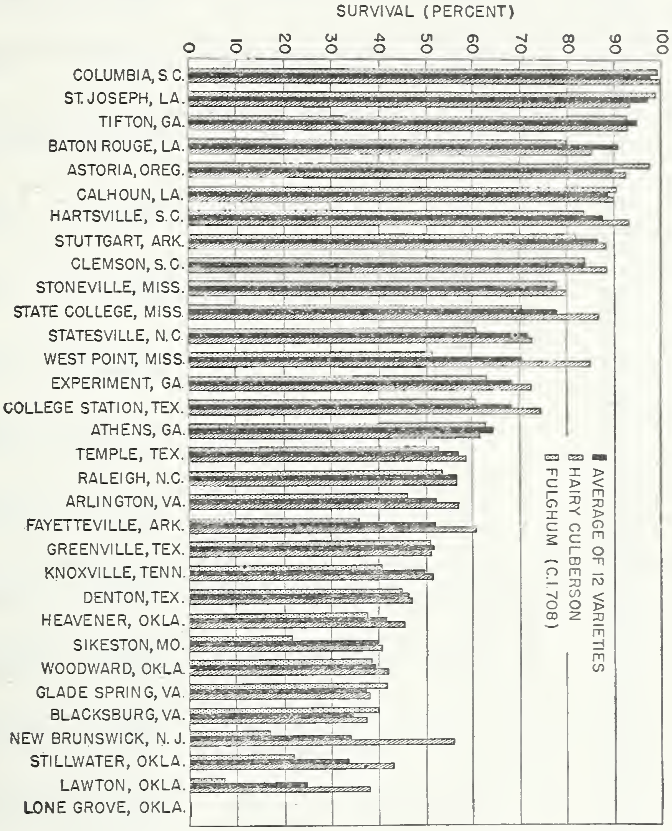

FIGURE 3.—Comparative survival of Hairy Culberson and Fulghum (C. I. 708) at 32 experiment stations.

TABLE 12.—*Summarized annual survivals of winter oat varieties and average survival compared with that of the Winter Turf variety*

Species, group, and variety or selection	C. I. No.	1927 (5 stations)	1928 (6 stations)	1929 (9 stations)	1930 (10 stations)	1931 (10 stations)	1932 (19 stations)	1933 (20 stations)	1934 (17 stations)	1935 (19 stations)	1936 (23 stations)	Straight average	Station years	Weighted average	Weighted average expressed in percentage of the 2 Winter Turfs for the same stations
Avena sativa															
Bicknell:		*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Number*	*Percent*	*Percent*
Bicknell	3218	60.6	50.9	89.4	31.8	88.5	87.2	79.9	84.3	74.5	57.4	70.5	138	72.8	106.6
Black Winter:															
Tech	947	53.5	40.8	81.0	31.7	88.1	81.8	75.3	77.4	68.7	52.7	65.1	138	67.6	99.0
Culberson:															
Culberson	273	58.6	37.0	86.7	34.0	88.1	90.3	84.8	83.2	74.2	53.2	69.0	138	72.3	105.9
Dwarf Culberson	748	63.3	44.5	87.1	30.2	91.6	84.6					66.9	59	71.1	104.6
Hairy Culberson	2505	62.6	60.9	86.4	36.5	90.0	87.7	81.4	82.2	75.2	56.5	71.9	138	73.5	107.6
Arkansas selection 160	2502			81.0	26.7	92.4	84.8					71.2	48	73.6	98.1
Winter Turf:															
Winter Turf	3295	58.2	18.3	85.0	20.6	92.0	89.0	77.8	75.6	71.5	51.7	64.0	138	67.9	100.0
Do	3296	56.0	23.7	85.9	22.1	91.6	89.9	76.9	77.8	72.5	52.4	64.9	138	68.7	
Spören Gray Winter	2506				28.0	[1] 89.0	86.5	78.9	85.7	75.2	54.8	71.2	117	72.2	103.6
Lee:															
Custis	2041	56.2	38.5	83.0	23.5	90.8	86.5	76.2	80.7	71.2	51.1	65.8	138	68.6	100.4
Lee	2042	51.3	25.8	85.2	24.5	89.8	91.3	74.7	80.9	68.1	48.8	64.0	138	67.7	99.1
Avena byzantina															
Fulghum:															
Fulghum	708	53.3	[2] 44.9	81.6	17.9	88.1	75.9	[1] 63.5	70.1	63.5	48.2	60.7	137	61.9	90.4
Fulghum (winter type)	2498		33.5	85.3	27.2	93.1	89.5	74.1	79.0	68.7	54.5	67.2	133	69.6	101.2
Do	2499	60.9	27.6	87.1	28.3	91.7	90.8	74.9	80.2	70.9	57.6	67.0	138	70.4	103.1
Do	2500		26.2	89.2	22.6	92.6					51.6	56.4	58	56.9	102.3
Do	3232				25.8	[1] 91.4	87.4	73.5	82.4	71.8		72.1	94	74.2	100.1
Fulghum (winter type, Tennessee selection 090)	3175									[1] 77.9	62.7	70.3	41	69.4	114.9
Red Rustproof:															
Texas Red	775	50.5	6.3	83.4	20.8	90.7	86.2					56.3	59	64.3	94.6
Ferguson No. 71	844	46.7	11.4	82.0	20.9	91.1	88.1	72.4	79.1			61.5	96	69.0	96.5
Ferguson No. 922	2150		6.5	82.2	24.3	87.5	84.6	69.8	74.8	65.6	41.9	59.7	133	63.0	91.6
Hastings Hundred Bushel	2462		10.5	89.2	21.3	91.9	86.4	65.7	74.2	63.7	44.4	60.8	133	63.5	92.3
Appler	1815	63.3	43.5	87.6	23.8	92.2	84.6	68.0	79.6	61.6	44.2	64.8	138	65.5	95.9

Nortex	2382		20.5	[1] 81.2	23.2	90.7	88.2	66.1	75.0	66.0	42.0	61.4	132	63.7	92.9
Texas No. 1118	1450	56.6										56.6	5	56.6	99.1
Texas No. 1118-69	2503			87.2	14.2	89.6						63.7	29	62.9	95.9
Miscellaneous strains:															
Culred	3217	51.2	26.3	81.2	24.5	85.0	87.8	73.9	81.1	72.7	49.2	63.3	138	67.2	98.4
Alber	2766							[1] 48.0	57.3	45.8	30.8	45.5	78	44.4	64.5
Coker 7a-20-5-3	2504			84.1	26.5							55.3	19	53.8	103.9
Norton	2501			77.8								77.8	9	77.8	91.0
Norton strain 3	2909						82.3	67.5	76.8			75.5	56	75.3	92.6
Burt Georgia 25-3	2684						86.4	70.1	84.7			80.4	56	80.1	98.5
Victoria	2401							[1] 30.1	32.4			31.3	36	31.2	40.9
Bond	2733							[1] 43.5	41.4			42.5	36	42.5	54.6
Coker selection Big Boy	2910						84.2	69.1	75.6			76.3	56	76.2	93.7
Coker selection 32-1	3026								[3] 83.8	72.7	53.8	70.1	55	67.4	102.7
Coker selection 33-50	3167									60.9	38.9	49.9	42	48.9	80.0
Coker selection 33-47	3176									64.5	47.9	56.2	42	55.4	90.7
Markton × Red Rustproof	3178									[4] 70.2	49.7	60.0	38	57.8	93.1
Do	3179									[4] 70.9	45.1	58.0	38	55.3	108.4

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[1] Average of 1 less station than in heading.

[2] A hardier strain of Fulghum was substituted for C. I. 708.

[3] Average for 13 stations.

[4] Average for 15 stations.

TABLE 13.—*Annual and 10-year average survivals of 12 oat varieties at all stations where differential killing occurred*

Variety or selection	C. I. No.	Survival in—										Weighted average for 10 years	Percentage of Winter Turf[1]
		1927	1928	1929	1930	1931	1932	1933	1934	1935	1936		
		Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	
Hairy Culberson	2505	62.6	60.9	86.3	36.5	90.0	87.7	81.4	82.2	75.2	56.5	73.5	107.6
Bicknell	3218	60.6	50.9	89.4	31.8	88.5	87.2	79.9	84.3	74.5	57.4	72.8	106.6
Culberson	273	58.6	37.0	86.7	34.0	88.1	90.3	84.8	83.2	74.2	53.2	72.3	105.9
Fulghum (winter type)	2499	60.9	27.6	87.1	28.3	91.7	90.8	74.9	80.2	70.9	57.6	70.4	103.1
Winter Turf	3296	56.0	23.7	85.9	22.1	91.6	89.9	76.9	77.8	72.5	52.4	68.7	100.6
Custis	2041	56.2	38.5	83.0	23.5	90.8	86.5	76.2	80.7	71.2	51.1	68.6	100.4
Winter Turf	3295	58.2	18.3	85.0	20.6	92.0	89.0	77.8	75.6	71.5	51.7	67.9	99.4
Lee	2042	51.3	25.8	85.2	24.5	89.8	91.3	74.7	80.9	68.1	48.8	67.7	99.1
Tech	947	53.5	40.8	81.0	31.7	88.1	81.8	75.3	77.4	68.7	52.7	67.6	99.0
Culred	3217	51.2	26.3	81.2	24.5	85.0	87.8	73.9	81.1	72.7	49.2	67.2	98.4
Appler	1815	63.3	43.5	87.6	23.8	92.2	84.6	68.0	79.6	61.6	44.2	65.5	95.9
Fulghum[2]	708	53.3	44.9	81.6	17.9	88.1	75.9	63.5	70.1	63.5	48.2	61.9	90.4
Average		57.1	36.5	85.0	26.6	89.7	86.9	75.6	79.4	70.4	51.9		

[1] Average of 2 Winter Turf strains.

[2] A hardier strain was substituted in 1928.

TABLE 14.—*Survival of winter oat varieties at 31 of the 32 stations at which winter hardiness nurseries were grown* [1]

Rank	State	Station	Years grown	Hairy Culberson, 2505	Bicknell, 3218	Culberson, 273	Fulghum (winter type), 2499	Winter Turf, 3296	Custis, 2041	Winter Turf, 3295	Lee, 2042	Tech, 947	Culred, 3217	Appler, 1815	Fulghum, 708	Average
				Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1	South Carolina	Columbia	2	100.0	99.5	97.9	92.5	97.9	96.3	99.0	98.9	93.9	100.0	99.5	99.5	97.9
2	Louisiana	St. Joseph	1	93.2	98.7	98.9	92.0	95.4	97.6	100.0	98.7	96.1	100.0	100.0	98.8	97.5
3	Georgia	Tifton	5	92.4	95.5	94.5	97.4	93.5	95.8	93.2	95.5	93.7	95.5	97.9	92.3	94.8
4	Louisiana	Baton Rouge	5	85.4	93.5	86.9	92.7	95.3	91.9	94.8	94.4	91.0	93.3	94.6	80.1	91.2
5	Oregon	Astoria	1	92.5	75.8	68.7	94.9	98.9	100.0	89.4	85.1	83.7	98.9	95.5	97.9	90.1
6	Louisiana	Calhoun	5	89.9	92.3	91.6	91.3	91.9	83.5	90.1	85.5	86.3	85.5	85.5	90.8	88.7
7	South Carolina	Hartsville	8	93.1	94.3	90.9	88.1	87.9	88.9	86.5	84.7	87.5	85.3	84.1	83.7	87.9
8	Arkansas	Stuttgart	6	88.3	86.9	92.8	88.8	89.3	83.3	85.0	88.0	87.1	83.6	81.5	82.0	86.4
9	South Carolina	Clemson	10	88.5	88.0	83.6	80.9	83.7	85.8	76.7	83.6	86.2	80.2	85.3	83.9	83.9
10	Mississippi	Stoneville	7	80.1	79.4	77.8	80.1	77.3	80.0	77.4	78.1	80.7	76.8	73.7	76.2	78.1
11	do	State College	9	86.6	80.6	81.8	68.5	76.6	78.2	80.3	77.3	75.9	80.0	68.8	70.2	77.9
12	North Carolina	Statesville	4	72.4	73.2	72.1	75.5	74.5	81.2	64.6	72.3	68.6	73.4	69.8	60.6	71.5
13	Mississippi	West Point	6	85.0	74.6	84.2	62.5	80.3	72.7	79.7	66.0	72.2	62.3	63.8	51.6	71.2
14	Georgia	Experiment	10	72.3	70.9	70.4	70.1	69.0	68.8	69.0	66.1	64.6	65.9	66.7	63.1	68.1
15	Texas	College Station	9	74.6	71.9	73.4	67.6	65.6	67.4	66.3	66.1	70.7	69.6	63.4	60.2	68.1
16	Georgia	Athens	7	61.5	67.2	64.0	65.2	64.7	66.2	66.5	64.9	60.8	59.9	65.7	62.5	64.1
17	Texas	Temple	5	58.6	59.3	59.0	60.2	56.6	58.0	56.2	54.6	53.0	56.0	58.0	52.7	56.9
18	North Carolina	Raleigh	3	56.6	64.5	58.8	58.0	56.1	55.3	55.7	57.8	54.0	52.7	59.3	53.3	56.8
19	Virginia	Arlington	9	56.9	59.4	54.0	48.8	46.9	54.5	46.4	53.1	53.3	50.6	55.0	46.1	52.1
20	Arkansas	Fayetteville	10	60.7	59.6	60.1	59.4	47.9	50.0	51.4	44.4	50.4	54.5	49.1	35.7	52.0
21	Texas	Greenville	8	51.3	54.1	50.2	53.6	50.0	53.3	50.2	51.9	53.9	52.2	47.0	50.9	51.6
22	Tennessee	Knoxville	7	51.1	44.6	50.2	53.9	52.1	50.8	51.5	53.2	45.9	47.5	51.7	40.2	49.4
23	Texas	Denton	9	46.8	48.1	49.0	52.7	45.8	41.4	45.1	44.8	44.3	45.4	46.4	45.1	46.2
24	Oklahoma	Heavener	2	45.5	40.7	48.1	37.9	47.1	48.4	46.0	40.4	40.6	41.8	21.5	37.4	41.3
25	Missouri	Sikeston	1	40.7	57.7	69.6	54.9	33.3	25.9	34.4	57.1	38.9	29.9	13.0	21.7	39.8
26	Oklahoma	Woodward	5	42.0	40.0	39.7	40.0	40.0	39.4	38.0	39.5	40.0	38.1	37.2	38.6	39.2
27	Virginia	Glade Spring	3	37.8	37.4	36.4	32.7	35.6	35.5	34.4	36.6	45.3	38.8	33.3	41.8	37.1
28	do	Blacksburg	7	37.6	36.4	37.3	40.9	29.2	33.5	38.3	33.5	25.9	26.3	41.0	40.0	34.5
29	New Jersey	New Brunswick	4	55.9	45.9	45.1	31.6	34.6	28.3	29.8	32.8	39.0	29.9	35.1	16.9	34.0
30	Oklahoma	Stillwater	5	43.0	40.4	39.7	36.2	32.7	29.1	31.9	33.9	30.1	37.3	22.7	22.0	33.3
31	do	Lawton	1	38.0	30.4	27.0	26.4	31.5	27.1	25.0	25.0	20.0	30.2	4.7	7.1	24.4
	Weighted average for years in which differential killing occurred			73.5	72.8	72.3	70.4	68.7	68.6	67.9	67.7	67.6	67.2	65.5	61.9	

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[1] Winter-hardiness nurseries were grown at Lone Grove, Okla., in 1933 and 1935, but no plants survived; at Arlington, Va., in 1931 no seedlings emerged in the fall owing to drought.

Differences at all of these stations except Blacksburg should be regarded as of no significance, because of the brief period of testing or a high average survival for all varieties. At Blacksburg, Fulghum (C. I. 708) survived somewhat better than Hairy Culberson. At West Point, Miss., Fayetteville, Ark., Sikeston, Mo., and New Brunswick, N. J., Fulghum was much less hardy than Hairy Culberson.

Despite the above, there seems to be little or no justification for a general recommendation of Fulghum (C. I. 708) as a hardy variety either for commercial production or as a parent in breeding for greater winter hardiness. Certainly it is less hardy than other varieties at most stations, and the differences in its favor elsewhere are too small to warrant serious consideration until more firmly established. Comparisons between other varieties show even less evidence of differential response, so it would appear that the discussion of relative hardiness from these points of view can be based safely on average results.

It is of special interest that four varieties, viz, Hairy Culberson, Bicknell, Culberson, and Fulghum (winter type, C. I. 2499) (table 13) had an average survival exceeding that of the two strains of Winter Turf. Previously, Winter Turf had been considered the most hardy of all oat varieties. Although differences are not great, the average survival of Hairy Culberson being less than 8 percent above that of Winter Turf, they are sufficiently consistent from year to year to indicate they are real and not due to random errors. Some of the newer varieties tested for a shorter period appear even more promising. Thus, the average survival of the Fulghum (winter type, Tenn. sel. 090, C. I. 3175), grown at 18 stations in 1 year and at 23 in another, is 69.4 percent, as compared with an average of 60.5 for the two Winter Turf Strains and 64.4 percent for Hairy Culberson for the same tests. These results suggest that progress has been made. Much is yet lacking, however, as even the most hardy varieties do not survive the winters as well as many winter varieties of rye, wheat, and barley. None of the many varieties tested has proved to be much superior in winter hardiness to those just mentioned or to the varieties generally grown in the winter-oat region.

Among the 39 varieties and strains included in these experiments, 12 usually have been classed as belonging to *Avena sativa*, 16 to *A. byzantina*, and 11 are known to have resulted from hybrids between the two species. Prior to the experiments reported here, it was believed that varieties classed morphologically as *A. sativa* offered the most promise for breeding hardier varieties. These experiments have indicated that the *A. sativa* variety, Winter Turf, long considered the most hardy, probably is less hardy than several derived from *A. byzantina*. The origin of the most hardy varieties, some of which have been classed as *A. sativa*, traces either directly or indirectly to selections from some variety of *A. byzantina* similar to Red Rustproof. Strangely, however, no known strain of Red Rustproof is exceptionally hardy.

Although all these superior hardy oats come from *A. byzantina*, they also have many characters common to *A. sativa* and seem to have resulted from crosses between these species. The results suggest the possibility of producing hardier oats by species hybridization.[3] In this connection, both of the hardy strains, C. I. Nos. 3178 and 3179 (table 12), resulted from crosses made by R. P. Bledsoe between Red Rustproof and Markton, the latter an *A. sativa* spring oat. In 38 comparable tests, the percentage of survival of these strains has been 57.8 and 55.3 percent, respectively, as compared with 51.3 for Appler, 51.8 for Nortex, and 52.1 for Hastings, all leading Red Rustproof varieties. The increase for C. I. 3178 has been from 10.9 to 12.7 percent above the Red Rustproof strains.

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[3] COFFMAN, F. A. SPECIES HYBRIDIZATION, A PROBABLE METHOD FOR PRODUCING HARDIER WINTER OATS. (Note) Amer. Soc. Agron. Jour. 79–81. 1937.

RELATION OF SURVIVAL TO TEMPERATURE

The data from all stations have been studied in relation to factors affecting winter-killing, particularly heaving, as well as temperature and soil type. Snow cover during periods of low temperature also was considered, but the data were too meager to admit of any general deductions. No relation between winter survival and altitude was evident, except as altitude is related to temperature. The relation of survival to the absolute minimum winter temperature and to soil type is shown in table 15 and figure 4. The survivals shown are averages of the 12 varieties grown in all tests, irrespective of the occurrence or extent of winter injury, including the data for the entire 179 station years.

Table 15.—*Relation of minimum winter temperature and soil type to winter-killing of oats*

Minimum winter temperature recorded (° F.)	Sand and sandy loams		Silt and silt loams		Clay loams		Houston clay	
	Station years	Average survival	Station years	Average survival	Station years	Average survival	Station years	Average survival
	Number	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*
16 and above	22	91.9	10	94.7	11	82.8	6	96.3
15 to 6	25	71.6	20	71.5	10	58.7	9	53.8
5 to −4	6	31.7	23	35.8	7	24.3	4	15.6
−5 and lower	2	0	11	31.7				

The survival decreases with minimum temperature, as would be expected. One station (Fayetteville) shows a very high survival (81.7 percent), with a low minimum temperature (−13° F.), and at New Brunswick a moderate survival (39.0 percent) was recorded with a low temperature (−14°). These good survivals probably were due to snow cover, as precipitation was recorded at both points immediately preceding the date of the low temperatures.

On the other hand, there were about 25 tests in which the survival was very low (25 percent or less) with no temperatures below zero. It is believed that in many cases this resulted from fall drought. Certain other departures from the usual relation between temperature and killing appear to be associated with soil type as explained later.

RELATION OF SOIL TYPE TO WINTER-KILLING

The soils on which the winter-hardiness nurseries have been grown may be classified into four general types, as follows: (1) Sand or sandy loam, (2) silt loam, (3) clay loam, and (4) Houston clay. The data

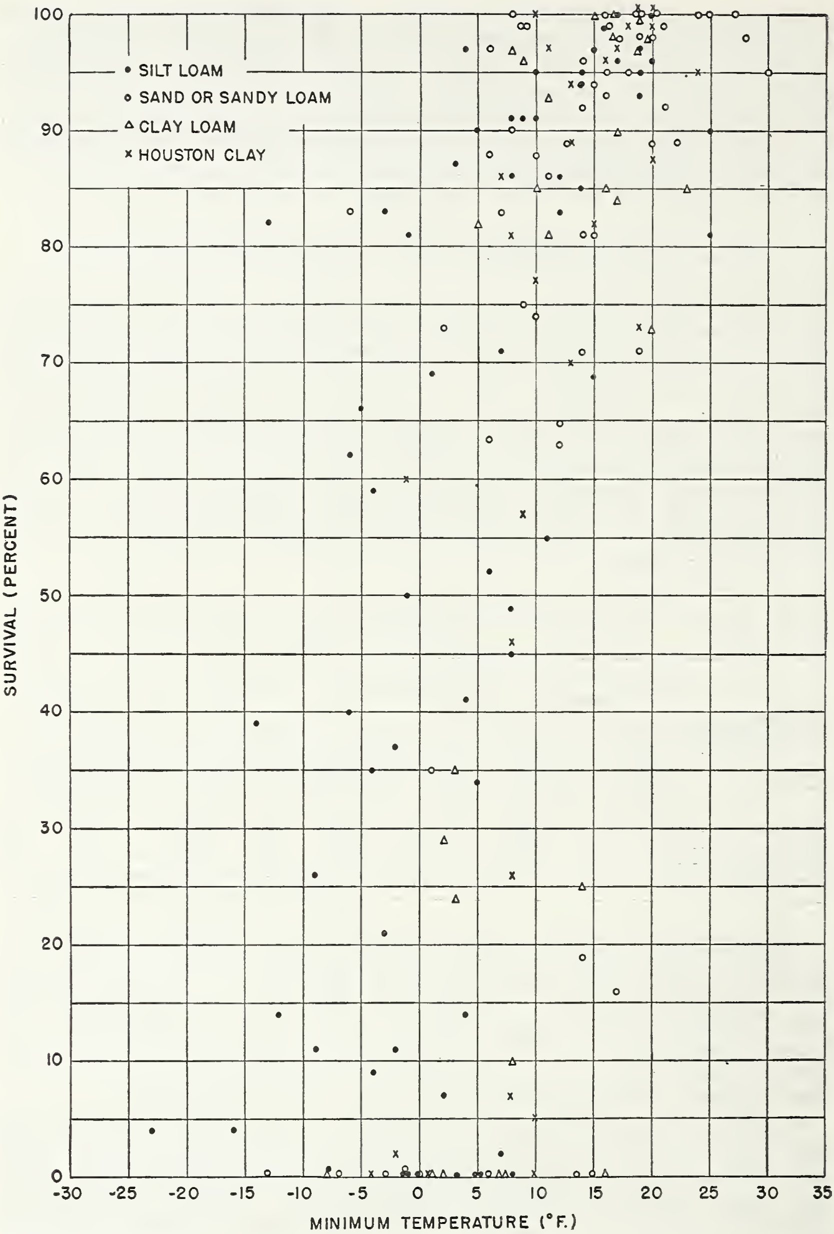

FIGURE 4.—Relation of soil type and absolute minimum temperature to survival of 12 oat varieties grown in all tests.

for the 166 station years indicate (table 15) that (1) killing was unusual on any soil when temperatures remained above 16° F., throughout the winter, (2) in the absence of snow covering, killing was nearly always complete on all soil types when temperatures fell to −5° or lower, and (3) when minimum temperatures fell below 16°, but not lower than −4°, the amount of killing differed with soil type. The heavier the soil type, the more frequently killing occurred, possibly because of greater heaving.

WINTER-KILLING AT WESTERN VERSUS EASTERN STATIONS

The average survivals at stations in Louisiana, Texas, and Oklahoma were lower than for corresponding temperatures at stations farther east. This is shown in table 16, in which data from 12 stations in the Appalachian and Atlantic coastal region are compared with those from the stations west of the Mississippi River. The differences may have been due to less protection from snow, to soil type, wind, or to other causes related to the relatively dry winters characteristic of most of these locations. The data available are insufficient to determine the relative importance of these factors.

Table 16.—*Survival of winter oats in the eastern Appalachian and Atlantic coastal region, compared with that west of the Mississippi River*

Minimum winter temperature recorded (° F.)	Appalachian and Atlantic coast region (12 stations)		Western region (10 stations)	
	Station years	Survival	Station years	Survival
	Number	*Percent*	*Number*	*Percent*
16 and above	22	88.6	17	91.9
15 to 6	31	71.0	18	56.5
5 to −4	18	40.5	12	6.1
−5 and lower	5	27.4	3	.1

ADAPTATION OF VARIETIES IN DIFFERENT AREAS

Figure 1 shows the location of stations cooperating in the hardiness nursery experiments with reference to temperature zones, based on average minimum winter temperatures. The weighted-average survival percentages of the 12 varieties were 92.7, 73.9, 55.2, and 44.1 when grown in zones where average minimum winter temperatures are above 20° F., 20° to 10°, 10° to 0°, and 0° to −10°, respectively. In the first zone, represented by 11 tests, no serious killing occurred. In the second zone (20° to 10°), represented by 66 station-years, all plants survived in 8 tests, whereas complete killing occurred in 5. Even the less hardy varieties usually survived in both of these warmer zones. Since complete killing was recorded only 5 times in a total of 77 station-years, it would appear that in these areas winter hardiness usually may be considered only of minor importance in oat production. In the third zone, where average minimum winter temperatures range from 10° to 0°, complete killing was recorded in 12 of the 79 station-years, and the average survival of all varieties was only 55.2 percent. The average for Hairy Culberson, the most hardy, was only 59.2 percent. Only the more hardy varieties are adapted in this zone. Red Rustproof and Fulghum frequently are winter-killed.

Three stations are located in the fourth zone where the minimum temperature averages 0° or below. In 4 of the 20 station-years representing this zone, all varieties were completely killed, and the average survival was only 44.1 percent. Hairy Culberson survived only 51.1 percent. This clearly indicates that until more hardy varieties are available, fall oat production is decidedly hazardous in this area. It also appears useless to attempt to grow any but the most winter-hardy varieties.

SUMMARY AND CONCLUSIONS

Uniform winter-hardiness nurseries of oat varieties were grown for 1 or more years at each of 32 experiment stations in the Southern winter-oat areas during the 10-year period from 1927 to 1936. These included many varieties and a wide range of soil and climatic conditions. Data were accumulated for 179 station-years during which differential killing occurred in 138. In other cases there was complete killing or none.

Hairy Culberson (C. I. 2505), on the average, survived best, followed by Bicknell, Culberson (C. I. 273), and Fulghum (winter type, C. I. 2499). Two typical strains of Winter Turf, formerly considered the most hardy winter oat, ranked fifth and seventh of 12 varieties grown in all tests. Fulghum (winter type, Tenn. sel. 090, C. I. 3175), tested for only a short period, appears to be exceptionally hardy.

The hardy varieties, Hairy Culberson, Culberson, Bicknell, and Fulghum (C. I. 2499), all probably resulted from hybrids between the two species, *Avena sativa* and *A. byzantina*. Markton, a nonhardy spring oat, when crossed with Red Rustproof, produced hybrids that were more hardy than Red Rustproof, although less hardy than certain other varieties. Species hybridization and the use of spring varieties in crossing may have some promise for increasing the winter hardiness of oats.

In the area in which winter oats are grown, killing of oats in the nurseries was of no consequence in the most mild southern zone where the average minimum winter temperature was 20° F. or above, seldom was serious in the zone having a 20° to 10° minimum temperature, often occurred in the zone of 10° to 0° minimum temperature, and was usually severe and often complete in the northern zone, where the average minimum temperature was 0° or below. Only the most hardy varieties can be expected to survive where the minimum winter temperature average is below 0°. The nurseries provided little information as to relative hardiness of different varieties in the most southerly zone, where survival was usually complete, or in the northern zone, where all varieties frequently were killed.

The rank in the hardiness of the oat varieties at different stations and in different years was rather similar. In general, at corresponding absolute minimum temperatures, killing increased as the soils became progressively heavier. Killing was infrequent on any soil type when the air temperature remained above 15° F. At temperatures below −5°, in the absence of snow covering, killing was usually severe or complete.

No relation between winter survival and altitude was evident, except as altitude is related to temperature.

Winter-killing appeared to be more severe west of the Mississippi River than under comparable temperature conditions in the East.

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